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LABORATORY MANUAL
OF
ALTERNATING CURRENTS

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LABORATORY MANUAL
OF
ALTERNATING CURRENTS

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OF
ALTERNATING CURRENTS

BY

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PREFACE

OWING to the dearth of alternating-current textbooks replete with simple experiments the writer has prepared the following pages for the use of students whose electrical training includes only the essentials of the subject. The manual presupposes a working knowledge of direct currents and magnetism and may be used as the basis for a supplementary course in alternating currents. For more advanced study the writer recommends, and uses in his classes at the Shawinigar Technical Institute, textbooks requiring special investigation and larger laboratory equipment.

LLOYD C. EDDY.

SEPTEMBER 18, 1915.

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MANUAL OF ALTERNATING CURRENTS

EXPERIMENTAL STUDY OF ALTERNATING CURRENTS

EXPERIMENT 1: TO DISTINGUISH AN ALTERNATING CURRENT FROM A DIRECT CURRENT

(*a*) Connect a carbon-filament lamp to a direct-current circuit and notice whether or not the filament vibrates when a magnet is held near the glass bulb.

(*b*) Connect the same lamp to an alternating-current circuit and repeat observations.

(*c*) Reduce the frequency of the current to a very low value (by reducing the speed of the alternator) and try to count the number of vibrations of the filament per minute. Is this equal to the frequency?

(*d*) Determine the highest frequency at which you can count the vibrations of the filament.

(*e*) What caused the vibrations of the filament?

(*f*) At which frequency did the lamps appear to give the best light?

(*g*) Try the same experiment, using a metallic filament lamp.

EXPERIMENT 2 : EFFECTS OF CHOKE COILS

Connect ten 16-candle-power lamps, 3 voltmeters, and several coils of wire wound about a closed iron core to a 30-cycle alternating current as in Fig. 1.

(*a*) Measure the voltage drops, V_r and V_l, across the lamp bank and inductance coil and compare with the total voltage drop, V_t.

(*b*) What causes the sum of the readings of V_r and V_l to be greater than V_t?

(*c*) Take similar readings at frequencies of 15, 20, 25, and 30 cycles.

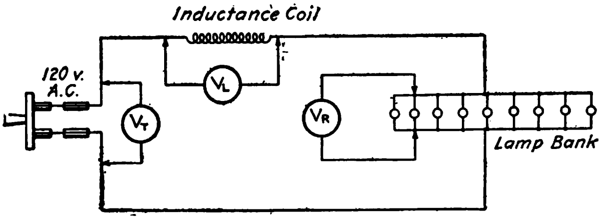

FIG. 1.

(*d*) Show (preferably by means of a plotted curve) how the ratio $\frac{V_r+V_l}{V_t}$ varies with increase of frequency.

(*e*) Repeat, using direct current.

EXPERIMENT 3: INDUCTANCE AND RESISTANCE

(*a*) Insert an ammeter in series with the lamps and coil of the preceding experiment and take readings of the voltmeters and ammeter at 30 cycles.

(*b*) Measure the resistance, R_r, of the 10 lamps in parallel and determine whether or not $V_r=IR_r$ (where I = current in amperes).

(*c*) Measure the resistance of the inductance coil and determine whether or not $V_l=IR_l$.

(*d*) Repeat at 15, 20 and 25 cycles, and determine the variation of $\frac{IR_l}{V_l}$ with increase of frequency.

(*e*) Draw full conclusions.

EXPERIMENT 4: FREQUENCY EFFECTS

(*a*) Connect the inductance coil to an alternating-current supply as in Fig. 2.

(*b*) Measure the volts and amperes at frequencies of 15, 20, 25 and 30 cycles per second.

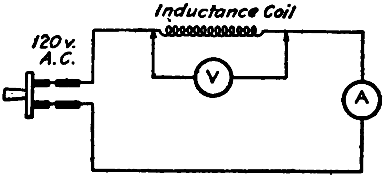

FIG. 2.

(*c*) Determine the inductance of the coil at each frequency by substituting the observed values of E, I, f and R_l in the formula:

$$L=\frac{\sqrt{E^2-I^2R_l^2}}{2\pi fI},$$

where R_l is the resistance of the coil as found in Experiment 3;
f is the frequency of supply;
E is the voltmeter reading;
I is the ammeter reading;
$\pi=3.1416$.

This formula for L is derived from the familiar formula:

$$E=IZ=I\sqrt{R^2+(2\pi fL)^2} \quad \text{(see theory of A. C.)}$$

(*d*) Does the inductance of a coil depend upon the frequency of the alternating current?

(*e*) Does the reactance ($2\pi fL$) of a coil depend upon the frequency of the alternating current?

EXPERIMENT 5: VECTOR DIAGRAM ANALYSIS

(*a*) Make connections as in Experiment 3, but halve the number of lamps in the circuit. Determine the voltmeter and ammeter readings when the circuit is supplied with 30-cycle current and measure the resistance of the five lamps in parallel.

(*b*) Construct a vector diagram of the relations as follows: From any point such as O draw a line OA equal in length (letting ·1 inch $=$ 5 volts) to the voltage drop, V_r, across the lamp bank. From A as a center, and with radius

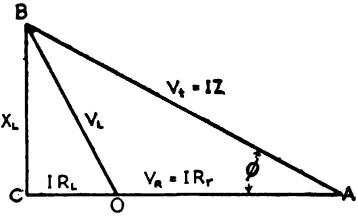

FIG. 3.

equal to total volts, V_t, strike an arc, and from O as a center and with radius equal to the voltage drop, V_l, across the coil, strike another arc, thus determining point B. This triangle shows the relative magnitude of the voltages and is a means of determining the phase relations of the current and voltage of the circuit (see theory). The voltage drop across the coil ($V_l = OB$) is caused by two distinct factors: the voltage drop due to the resistance, R_l, of the coil, and the voltage drop due to the inductance, L, of the coil. The former is equal to IR_l and the latter is equal to $IX = I \times 2\pi fL$ (see theory). Use, therefore, the values of L and R_l found in the preceding experiment and from the values of f, E and I, and R_r, above determined, calculate IX_l and IR_l. Now plot diagram (3) to scale.

(*c*) Repeat at frequencies of 15, 20 and 25 cycles and compare diagrams. Angle BCO is a right angle.

EXPERIMENT 6: TO DETERMINE FREQUENCY

(*a*) Connect a 2-microfarad condenser across a 50-volt circuit supplied with direct current and measure the current flowing.

(*b*) Connect the same condenser across a 50-volt alternating-current circuit and repeat.

(*c*) From your readings determine the frequency of the line

$$E = IZ = I\sqrt{O^2 + \left(\frac{1}{2\pi fC}\right)^2} = \frac{I}{2\pi fC} \quad \text{(see theory).}$$

(C = capacity of condenser.)

EXPERIMENT 7: POWER IN ALTERNATING-CURRENT CIRCUITS

(*a*) Measure the power consumed by ten carbon-filament lamps;

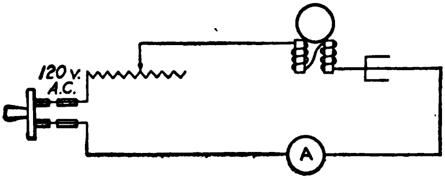

FIG. 4.

1. When supplied with direct current.
2. When supplied with alternating current.

(*b*) Compare results. Repeat, using metallic-filament lamps.

EXPERIMENT 8: EFFECT OF CONDENSERS UPON ALTERNATING-CURRENT CIRCUITS

(*a*) Connect a bell of high inductance, a variable resistance (150 to 400 ohms) and a condenser as in Fig. 4.

(*b*) Close the 120-volt alternating-current circuit and adjust the resistance, bell, and vibrator, etc., until the bell rings clearly during the entire time that the switch is closed.

(*c*) Insert condensers of varying size (connecting similar sizes in multiple if necessary) in the circuit and determine whether or not the operation of the bell is affected and whether or not it rings louder. Note current and voltage with each different arrangement. Does an increase in capacity increase or decrease the amount of current required to ring the bell?

(*d*) Repeat (*b*) and measure the current. Now insert condensers of varying size and adjust the resistance so as to maintain the current at a constant value. Which condenser requires the least amount of resistance in the circuit?

(*e*) Should you not be able to form accurate judgments concerning the loudness with which the bell rings under the different conditions, insert a bell having higher inductance or use a choke coil (noting current and voltage changes only).

EXPERIMENT 9: CAPACITY AND INDUCTANCE

(*a*) Connect an 18-ohm bell, a variable resistance (150 to 400 ohms) and a condenser to an alternating-current supply as follows:

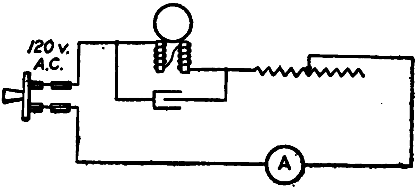

FIG. 5.

(*b*) Repeat the readings of Experiment 8.

(*c*) Adjust the condensers, variable resistance, etc., until you know what conditions are best suited for the operation of the bell, taking into account economy of current and power supplied.

EXPERIMENT 10: CAPACITY AND INDUCTANCE

(*a*) Determine whether or not the most economical arrangement of the apparatus of Experiment 9 is also the most economical when the frequency is changed from 30 cycles to 15 cycles.

(*b*) Repeat Experiment 9, using a lower frequency.

(*c*) Repeat at both frequencies, using a choke coil in place of the bell.

(*d*) Do the results of the preceding experiments suggest to you any other ways in which condensers might be made of practical benefit?

EXPERIMENT 11: CAPACITY AND INDUCTANCE

(*a*) Connect a bell to a bell-ringing transformer or other alternating-current low-voltage supply and lower the voltage until the bell just ceases to ring. Now connect condensers of variable capacity across the bell and note results. In case there are no marked results, use a bell of higher inductance.

(*b*) Try connecting the condenser in series with the bell and note whether or not the results are the same.

EXPERIMENT 12: VOLTAGE AND CURRENT RELATIONS IN BRANCHED CIRCUITS CONTAINING REACTANCE

(*a*) Connect a choke coil, voltmeter, ammeter, condensers, and variable resistance (lamp bank is preferable) as follows:

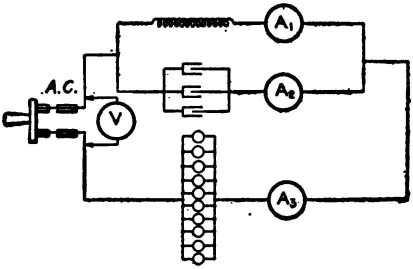

FIG. 6.

(*b*) Read volts and amperes in each branch at different values of resistance. Is the total current, *A*3, equal to the sum of the currents in the two branches?

(*c*) Plot a vector diagram of currents similar to that of Experiment 5 and determine the phase relation of the currents.

EXPERIMENT 13: POWER AND HEAT DEVELOPED IN CIRCUITS CONTAINING REACTANCE

(*a*) Adjust the number of parallel lamps in a lamp bank so that the total resistance in circuit will equal that of the inductance or choke coil used in preceding experiments (measuring the resistance either by voltmeter-ammeter method or by Wheatstone bridge as in direct-current work).

(*b*) Determine the power loss in each by means of a wattmeter, connecting to 30-cycle alternating current as follows: (Do not try to measure the power lost in the choke coil by connecting to direct current, for the wattmeter would " burn out " owing to the low resistance of the choke coil.)

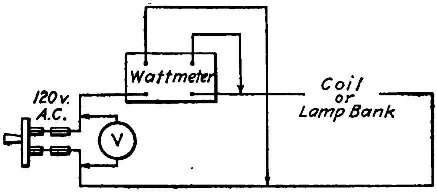

FIG. 7.

(*c*) Judging from your results, which do you think would be the most economical voltage regulator for an alternating-current arc lamp?

(*d*) Vary the frequency of supply current and repeat readings.

(*e*) Measure the heat developed in each device by measuring the current input (*heat*=I^2R).

(*f*) Which would be the safest device to use as regards overheating?

(*g*) Determine whether or not the frequency affects the amount of heat developed. Procure a thermometer and note the temperature rise of each during a given period of time when supplied with alternating currents of different frequencies.

(*h*) Why did not the choke coil consume as much power as the lamps of equivalent resistance?

(*i*) Multiply the current consumed by each by the voltage of supply and compare with the power consumed. What became of the excess current through the choke coil, i.e., why did it not cause the wattmeter to register?

(*j*) Study the underlying principles involved and try to think of some practical application of these principles. Report conclusions.

EXPERIMENT 14: POWER AND HEAT DEVELOPED IN CIRCUITS CONTAINING REACTANCE

(*a*) Insert a condenser in place of the choke coil of preceding experiment and determine whether or not there is any power loss in the condenser. Increase the number of condensers if necessary.

(*b*) Does a variation in frequency affect the loss?

(*c*) Is there any heat developed in the condenser?

(*d*) Report and explain results.

EXPERIMENT 15: A.C. TRANSMISSION LINE CHARACTERISTIC (NON-INDUCTIVE LOAD)

(*a*) Construct a simple artificial single-phase transmission line from high-resistance wire stretched back and forth across the room.

(*b*) Connect the power plant (alternator in laboratory) through a switch to one end of the line, and the lighting system (bank of incandescent lamps) to the other end of line.

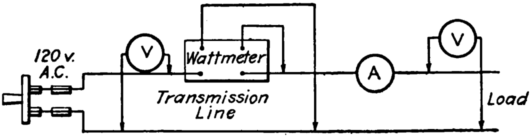

FIG. 8.

(*c*) Determine the power input and output and thus the efficiency of the line at ten different supply voltages ranging from 20 to 200 volts.

(*d*) Repeat with four different values of load on the lighting system.

(*e*) Determine the voltage drop from power plant to lighting system at each different value of load and frequency.

(*f*) What voltage would you advise using for this particular line and character of load (non-inductive) and why?

(*g*) Is one frequency of supply current any better than another for this kind of load, i.e., non-inductive lighting system?

(*h*) Supply a very low frequency current and notice the behavior of the lights.

EXPERIMENT 16: A.C. TRANSMISSION LINE CHARACTERISTICS (INDUCTIVE LOAD)

(*a*) Insert an inductive load (single-phase motor or, preferably, a choke coil) in place of the non-inductive lighting system used in the last experiment and repeat *c*, *e* and *f*, using a wattmeter to measure both the input and output.

(*b*) Compare the results of experiments 15 and 16 and draw conclusions.

(*c*) Determine the regulation of the line in each case under the varying conditions. It is important that the regulation of a transmission line should be low, as is at once obvious when we consider that the regulation of a transmission line equals:

$$\frac{(\text{No-load voltage at receiving end} - \text{full-load voltage at R.E.}) \times 100}{\text{Full-load voltage at receiving end}},$$

or

$$\frac{(E_0 - E_l) \times 100}{E_l}.$$

(*d*) Place the load at the middle of the line and repeat experiments 15 and 16.

(*e*) Determine the power factor at each end of the line and compare.

(*f*) In case the power factor at each end of the line is not the same, what is the cause of the difference?

(*g*) What do preceding experiments tell you regarding the effect that electrical capacity would have upon the transmission?

(*h*) Try to think of some way by which you can improve the efficiency and regulation of the line other than by changing the supply voltage, frequency, or load. Could condensers or inductance coils be arranged in the circuit in such a way as to improve transmission?

(*i*) What frequency of current would you advise using when the load is entirely inductive?

NOTE. Induction motors have considerable inductance, and lower the power factor of a line; nevertheless they are used considerably in industrial plants.

(*j*) "Try out" any measurements or changes which you may think of which might throw light on the performance of the line. Speak to the instructor first, however.

(*k*) What effect does distance of transmission (same resistance per mile) have upon the power factor at the receiving end? Make measurements or calculations.

EXPERIMENT 17: ALTERNATOR CHARACTERISTICS

Connect the field terminals of an alternator to a source of direct current through a rheostat, run the alternator at rated speed by means of an auxiliary motor belted to the machine, and measure the voltage of the alternator at ten different values of field current.

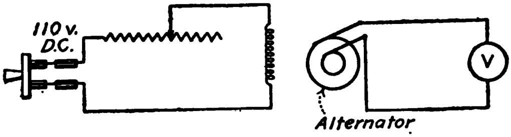

FIG. 9.

(*b*) Is the increase in voltage directly proportional to the increase in field current?

(*c*) Try to run the alternator and generate voltage with the field connected to a source of alternating current instead of direct current.

(*d*) What is the reason for the difference in results?

(*e*) With constant direct-current field excitation run the machine at several different speeds and measure the terminal voltage. Does variation in frequency have any effect upon the voltage generated?

EXPERIMENT 18: ALTERNATOR CHARACTERISTICS

(*a*) Connect a non-inductive load (lamp bank) to the alternator as follows:

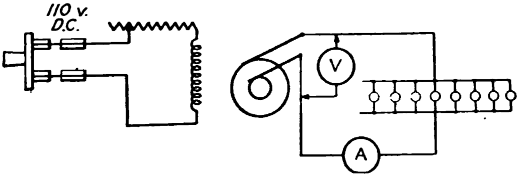

FIG. 10.

(*b*) Increase the field current from zero to such a value that the voltmeter registers 120 volts with one lamp connected in circuit.

(*c*) Maintaining the field current constant, increase the load, lamp by lamp, meanwhile taking readings of volts and amperes.

(*d*) Determine the regulation of the generator; i.e., the fall in voltage from no load to full load in per cent of the full-load voltage.

(*e*) What causes the voltage to decrease as load increases?

(*f*) Does an increase of load affect the speed of the machine?

EXPERIMENT 19: CHARACTERISTICS OF THREE-PHASE DELTA-CONNECTED SYSTEMS

THREE-PHASE VOLTAGE AND CURRENT RELATIONS WITH MESH OR "DELTA"-CONNECTED NON-INDUCTIVE LOAD

(*a*) Connect voltmeters, ammeters, and twenty-one carbon filament lamps to a 120-volt, three-phase supply as in Fig. 11.

(*b*) Determine the current and voltage relations in the three phases.

(*c*) Measure the current supplied to the seven lamps of *A* when connected directly to a 120-volt single-phase supply.

(*d*) How does this current (of *c*) compare with the current through ammeter *A*?

(*e*) Cut out the lamps in *A* and note the effect on the current and voltage relations.

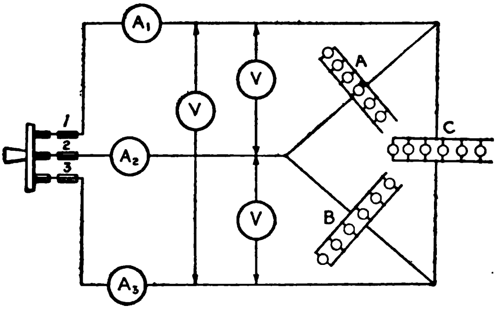

FIG. 11.

(*f*) Repeat for the lamps in *B* and *C*.

(*g*) Calculate the total power supplied when all of the lamps are burning.

(*h*) Disconnect wire No. 1 and measure the voltages. Explain results.

EXPERIMENT 20: CHARACTERISTICS OF THREE-PHASE STAR-CONNECTED SYSTEMS

THREE-PHASE VOLTAGE AND CURRENT RELATIONS WITH STAR-CONNECTED NON-INDUCTIVE LOAD.

(*a*) Connect voltmeters, ammeters, and twenty-one carbon filament lamps to a 120-volt, three-phase supply as in Fig. 12:

(*b*) Determine the voltage and current relations in the three phases and in the branches of the Y or star.

(*c*) Determine the current supplied to the lamps in branch *A* alone when supplied with single-phase 120-volt current.

(*d*) Compare the value of current obtained in *c* with that flowing through ammeters A_1 and A_2 respectively.

(*e*) "Cut out" branch *A* and measure the current and voltage relations in the three phases.

(*f*) Repeat for branches *B* and *C*.

(*g*) Compare the phase voltages (Vp) with the line voltages (V_l).

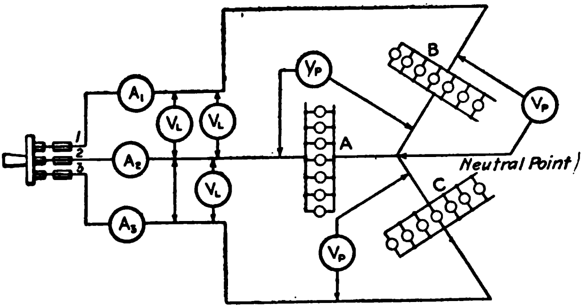

FIG. 12.

(*h*) Calculate the power supplied to the twenty-one lamps.

(*i*) Compare the results of Experiments 19 and 20 (fully) and draw conclusions.

(*j*) Disconnect wire No. 1 and measure the voltages. Explain results.

EXPERIMENT 21: POWER IN A THREE-PHASE SYSTEM

In Experiment 19 we found that the power supplied to a balanced non-inductive loaded three-phase system is equal to $EI\sqrt{3}$ where E is the line voltage and I is the current in one of the phases. Check this value of the power by means of the one wattmeter method as follows:

(*a*) Arrange the load (lamp bank) in mesh or delta according to the following sketch and insert the current coil of the wattmeter in one of the phases, say phase No. 2. Connect the potential coil of the wattmeter across lines 1 and 2 and read the power; then transfer terminal 1 to line 3 and read again (keeping the load constant). If this causes the wattmeter to read negatively, reverse the connections of the potential coil, i.e., from 1–3 to 3–1 and assign a negative value to this reading of the wattmeter. The total power supplied is equal to the algebraic sum of the wattmeter readings.

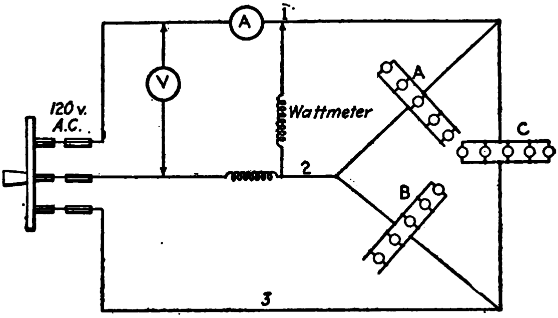

FIG. 13.

(*b*) Compare results with $EI\sqrt{3}$.

(*c*) Change the number of lamps in the load (keeping the same number in each phase) and repeat.

(*d*) Repeat observations and compare results with the results with unbalanced load.

EXPERIMENT 22: ROTARY CONVERTER

(Direct-current Side Only)

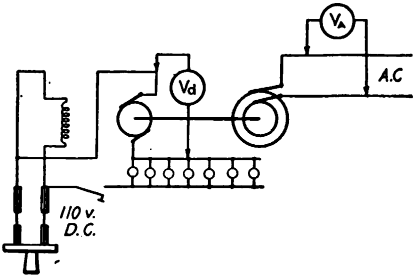

FIG. 14.

To start and operate a rotary converter from the direct-current side.

Connect as in Fig. 14. Practice starting and running from the direct-current side (just as you would a direct-current motor) using the lamp bank as starting resistance for the armature. Is $\frac{Va}{Vd}$ constant for all values of field current? Is it constant at all speeds? If not, does $\frac{Va}{Vd}$ increase or decrease as the field current or speed is increased?

EXPERIMENT 23: ONE WATTMETER METHOD—THREE-PHASE SYSTEM

Same as Experiment 21 except that the load is arranged in star instead of delta (as in Fig. 12).

EXPERIMENT 24: POWER FACTOR OF A SQUIRREL-CAGE INDUCTION MOTOR AT START

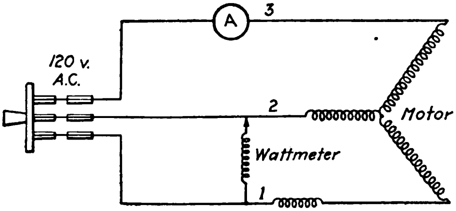

FIG. 15.

(*a*) Measure the current taken by each phase at the start.

(*b*) Measure each line voltage at the start.

(*c*) Connect the series coil of a wattmeter in one of the phases (say phase No. 1) and connect the potential coil of the wattmeter across phases 1–2, 2–3, 1–3, 2–1, 3–2 and 3–1 in succession and note the reading of the wattmeter for each position of the terminals when the motor is started.

(*d*) Repeat the readings with series coil connected in phases 2 and 3.

(*e*) Which reading or readings would you say gives the true power taken by the motor at the start (i.e., on closing switch)?

(*f*) Note the ammeter and voltmeter readings and determine the power factor of the motor at start.

EXPERIMENT 25: TO SYNCHRONIZE A ROTARY CONVERTER AND OPERATE FROM THE ALTERNATING-CURRENT SIDE

Make connections as follows:

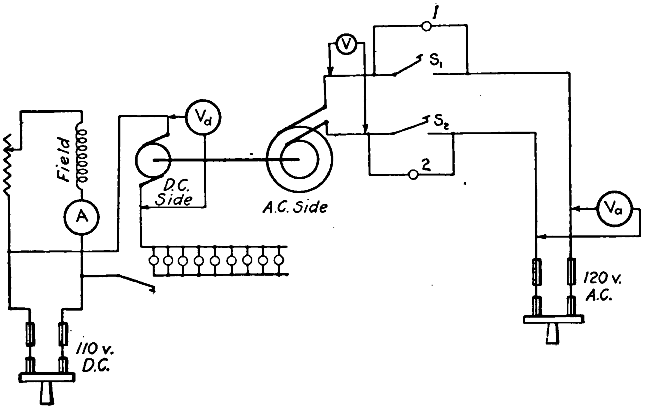

FIG. 16.

(*a*) Drive the converter from the direct-current side as in Experiment 24, and raise the frequency to that of the line to which you wish to synchronize.

(*b*) Adjust the field rheostat until the voltage on the alternating-current side is the same as that of the alternating-current line.

(*c*) Watch lamps 1 and 2 (which will flicker) and vary the speed of the converter slightly (by trial) until the lamps first light and then "go out" completely (alternately in succession).

(*d*) Watch for the moment when the lamps are "out" or very dim and close switches S_1 and S_2 at that moment.

(*e*) Disconnect the wires on the direct-current side from the line and allow the converter to run from the alternating-current side.

(*f*) Compare voltages on the direct-current and alternating-current side.

(*g*) Light lamps from the direct-current side and so determine that the rotary is converting alternating into direct current.

EXPERIMENT 26: SYNCHRONOUS MOTOR

(*a*) Excite the field of the synchronous motor with 120-volt direct current, inserting an ammeter and rheostat in the field circuit.

(*b*) Start the motor by belting it to an auxiliary motor (induction motor) or by the method of Experiment 22.

(*c*) Increase the speed of the motor so as to give the approximate frequency of the line to which you wish to synchronize $\left(\text{frequency} = \frac{\text{R.P.M.} \times \text{pairs of poles}}{60}\right)$.

(*d*) Make connections as follows:

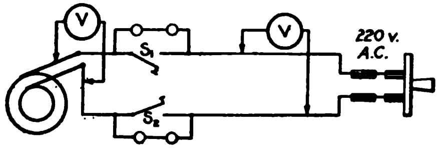

FIG. 17.

(*e*) Increase the voltage of the synchronous motor to that of the line by means of the field rheostat.

(*f*) Watch lamps 1 and 2 (which will flicker) and vary the speed of the synchronous motor slightly (by trial) until the lamps first light and then " go out " completely (alternately in succession).

(*g*) Watch for the moment when the lamps are " out " or very dim and close switches S_1 and S_2 at that moment.

(*h*) Throw off the belt and allow the motor to be driven from the alternating-current side.

(*i*) Determine the effect of varying the field current upon the operation of the synchronous motor.

EXPERIMENT 27: THE EFFECT UPON THE POWER FACTOR OF A TRANSMISSION LINE OF A VARIATION IN THE FIELD CURRENT OF A SYNCHRONOUS MOTOR WHICH IS FLOATING ON THE LINE

(*a*) Connect as follows:

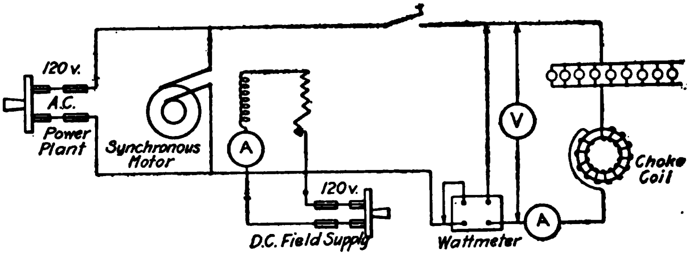

FIG. 18.

(*b*) Synchronize the synchronous motor to the transmission line as in Experiment 29 (also see Experiment 15).

(*c*) Vary the field current of the synchronous motor from .05 amp. to maximum in about eight steps and read true watts, volts, and amperes with full load at the end of the line, keeping the load constant.

(*d*) Calculate the power factor of the line in each case.

$$\left(\text{power factor} = \cos\phi = \frac{\text{true watts}}{EI}.\right)$$

(*e*) What effect does an increase in field current of the synchronous motor have upon the power factor?

EXPERIMENT 28: THE EFFECT UPON THE POWER FACTOR OF A TRANSMISSION LINE OF A SINGLE-PHASE MOTOR OPERATING AT FULL LOAD AT THE END OF THE LINE

Connect as follows:

(*a*) Load the single-phase motor by means of a prony brake and read watts, amperes, and volts at the receiving end for eight different values of load up to one and one-half times rated load.

(*b*) Determine the power factor of the line at these different loads.

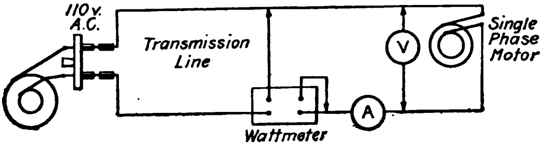

FIG. 19.

(*c*) Insert in place of the motor enough carbon filament lamps to consume the same amount of current, take readings as before, and note whether or not the power factor remains the same.

(*d*) Determine the effect of change of frequency of supply upon the operation of the motor.

(*e*) Will the motor operate on direct current?

(*f*) Why is this motor self-starting, whereas the synchronous motor was not self-starting?

EXPERIMENT 29: THREE-PHASE INDUCTION MOTORS

To compare the starting and running torques of rotor-wound and squirrel-cage type induction motors.

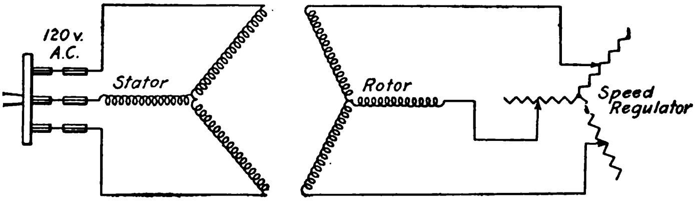

FIG. 20.

(*a*) By means of a prony brake or similar device determine the starting torque (foot-pounds) and the torque at rated speed of the rotor-wound induction motor.

1. With speed regulator at zero position.
2. With speed regulator set at other points (not the last two).

(*b*) Repeat the observations on the squirrel-cage motor.

(*c*) Which motor has the largest starting torque per horse-power of rated output?

(*d*) Compare the ratio of starting torque to running torque for each motor.

(*e*) Reduce the voltage supplied to the largest motor from 220 volts to 110 volts and repeat observations.

EXPERIMENT 30: TRANSFORMER REGULATION

(*a*) Connect the low-voltage side of a small transformer to the terminals of the single-phase alternator, being careful to keep the voltage of the latter at a low value. (The voltage of the high-tension side being many times this amount and therefore dangerous to handle.)

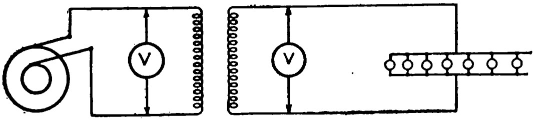

FIG. 21.

(*b*) With open secondary (i.e., high voltage on high-tension side) measure both the primary and secondary volts and so determine the ratio of the voltage transformation (and, incidentally, the ratio of the number of turns on primary and secondary coils) of the transformer.

(*c*) Load the secondary with a non-inductive load (preferably carbon filament lamps arranged in series-parallel). Vary the load from full-rated load to no load, measuring the voltage of both primary and secondary.

(*d*) Determine the " drop " and regulation of the transformer as explained by the instructor.

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